MEMORANDUM

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RE: Technical Review of "Dispersion Modeling Analysis of PSD Class I Increment Consumption in North Dakota and Eastern Montana"

I. Introduction

I have been asked by representatives of the Lignite Vision 21 Program to provide a written technical review of the Draft EPA Report entitled "Dispersion Modeling Analysis of PSD Class I Increment Consumption in North Dakota and Eastern Montana." This analysis developed SO_2 emission inventories for North Dakota and Eastern Montana, meteorological data for the region and used the CALMET/CALPUFF air quality model to predict PSD increment consumption in six nearby Class I areas. I understand that EPA is seeking technical comments on the following: 1) EPA's characterization of PSD increment consuming emissions and emissions from sources during base year periods; and 2) Whether the CALPUFF model inputs and settings have been selected in a manner that is technically sound and suitable for regulatory purposes.

This report contains my opinions regarding the adequacy of the Draft EPA Report.

As an initial matter, it is important to place these comments in the context of the technical adequacy of the tool used in the Draft EPA Report – the CALMET/CALPUFF model. EPA

proposed this model as a regulatory Guideline model (Appendix A) in 2000 and sought public input on this action.

While it has not yet done so, presumably, EPA may at some point in the future finalize the model based upon comments received. At present, however, it is important to understand the limitations of this proposed tool. Review of the EPA technical support documentation indicates that CALPUFF never underwent a model evaluation in the context for which it is being used in the present proposed regulatory application for North Dakota. In EPA's CALPUFF Rulemaking Docket, studies were presented during the course of public comment that showed the model could replicate, to some degree, limited inert tracer studies. However, no comparisons were provided to show the degree of accuracy (or not) of the CALPUFF model when the chemistry sections (for example SO_2 transformations) are being used as they are in the present Draft EPA Report. As a result of this very significant omission, which is not consistent with other EPA policies on model evaluations, comments were provided to EPA pointing out this substantive deficiency and a suggested approach for correcting it[1]. In response, EPA has concluded that since these issues pertain to Class I impacts, it is the obligation of the FLMs to address the accuracy of the model for such applications[2] and, as such, no credible technical resolution has been reached on this important issue.

There is a second significant issue regarding the application of the CALPUFF model to Class I impacts. Most of the guidance on how to apply CALPUFF to Class I areas has been formulated by the Interagency Workgroup on Air Quality Modeling (IWAQM). This group is comprised of FLMs and EPA. Unfortunately, this group is setting policy and guidance without providing any supporting technical documentation and is not allowing the public an opportunity to comment.

In the sections of this report that follow, specific technical comments are provided on:

1) Meteorological data;
2) Emission inventories;

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[1] GTI and AQRM, 2000, "Comments on EPA's Proposal to Add Seven New Modeling Techniques to Appendix W of 40 CFR Part 51".

[2] Tickvard, J., 2001, EPA OAQPS, Comments presented at AWMA Specialty Conference "Guideline on Air Quality Models, A New Beginning"

3) Model evaluation;
4) CALPUFF application and interpretation of results; and
5) Conclusions and Recommendations.

II. Meteorological Data

The Draft EPA Report utilizes a modeling domain that extended 640 kilometers east west and 460 kilometers north south. The reference point of the modeling domain (southwest corner) is approximately 200 kilometers west of the Montana North Dakota border. The size of the modeling domain is consistent with other recent applications of CALMET/CALPUFF. However, because of the use of chemical transformations over large distances, it is very important to verify that the wind fields both horizontally and vertically are accurate with respect to wind speed, wind direction, temperature and turbulence. This has not been done in a manner that is apparent in this case.

Raw meteorological data were obtained from 25 National Weather Stations, Federal Aviation Administration, US Military and Environment Canada for the period 1990 through 1994. The spacing of these stations provided good spatial representation over the modeling domain. This is not a typical application of CALMET where a prognostic meteorological model is used to supplement actual observations. Consideration should have been given to supplementing these observations with the output from a prognostic model such as MM5. EPA has run MM5 for 1996 and these data would have possibly been available for additional modeling, however, these data would have to be converted to a format compatible with CALMET. By using this approach, some of the meteorological data could have possibly been withheld from the CALMET modeling and used to independently verify the output from CALMET.

III. Emission Inventories

While the focus of these comments is on the Draft EPA Report, it is important to compare the emissions that were used by EPA to those contained in the State of North Dakota Department of Health (NDDH) Draft Report entitled "CALPUFF Analysis of Current PSD Class I Increment

Consumption in North Dakota and Eastern Montana Using Actual Annual Average SO_2 Emission Rates" Dated April 2002. Comparison of the emissions inventories relied upon by both agencies in their respective modeling analyses shows substantial differences between them and which therefore results in large differences in predicted increment consumption. Based on the information that is presented in the Draft EPA Report it is impossible to determine if EPA's inventory accurately represents changes in emissions without re-analyzing all of the raw emissions data. Because EPA has not presented a complete picture of emissions, it is impossible to review, comment and draw conclusions regarding the accuracy of the emissions. It is beyond the scope of these comments to recalculate and confirm emissions. However, given EPA's stated intent to possibly utilize the draft report for policy purposes, it is imperative that additional analyses be conducted to quantify the changes in emissions. Because this has not been done, any regulatory actions should not be initiated that result in significant cost to industry and affect future economic development for the State of North Dakota based on less than accurate information.

Baseline Emissions

In order to summarize emissions between the two studies a series of tables were developed based on information contained in both the Draft EPA and Draft NDDH reports. Table 1 presents a comparison of emissions when the SO_2 baseline was set. As indicated in this table, there are substantial differences between these two inventories.

This table indicates that the EPA inventory is about 22,000 pounds per hour or 51 percent lower than the NDDH inventory. It should be noted that there are a number of sources in the NDDH inventory that are not considered in the EPA inventory. By not including all of the emissions from all of the sources in the NDDH inventory, the EPA analysis does not credit the proper amount of emissions to the baseline inventory.

Table 1. Baseline Emissions for 1977

Source	NHHD Baseline (g/s)	NHHD Baseline (#/hr)	EPA Baseline (#/hr)	Difference (#/hr)
Antelope Valley Station 1				
Antelope Valley Station 2				
Coal Creek 1				
Coal Creek 2				
Coyote Station 1				
Grasslands Gas Plant				
Colstrip Station 3				
Colstrip Station 4				
Celp Boiler				
Leland Olds Station 1	407.60	3,235	2,499	736
Leland Olds Station 2	765.90	6,079	4,305	1,774
Stanton Station	268.00	2,127		2,127
Milton Young Station 1	585.90	4,650	3,972	678
Milton Young Station 2	618.10	4,906	5,635	-729
Heskett Station 1	65.20	517		517
Heskett Station 2	152.20	1,208	1,749	-541
Mandan Refinery	312.90	2,483		2,483
Lignite Gas Plant	36.00	286		286
Tioga Gas Plant	135.30	1,074		1,074
Beulah Station 1+2	17.27	137		137
Beulah Station 3-5	28.29	225		225
Neal Station 1 +2	44.70	355		355
Flying J Ref Heaters+Boiler 2	3.19	25		25
Flying J Boiler 1	1.32	10		10
Flying J Boiler 3	1.89	15		15
Royal Oak Boiler 1-3	21.70	172		172
Royal Oak ACC	200.50	1,591		1,591
Little Knife Gas Plant				
Dakota Gasification Synfuels Plant				
Total	**(#/hr)**	**29,097**	**18,160**	**10,937**
Total	**(t/yr)**	**127,444**	**79,541**	**47,903**

Note: Difference is NDDH-EPA

Since the baseline emission inventory is the starting point against which the change in air quality is calculated (increment), this inventory is a critical portion of the increment analysis. Given that this inventory reflects actual emissions when the baseline was set (1977) this is a formidable task. In trying to estimate emissions from that time period there is likely a lack of engineering data or measurements upon which emission estimates can be made.

Current Emissions

The second inventory that needs to be developed is for current conditions. Table 2 presents the NDDH and EPA estimates of current emissions.

Using CEM data from the EPA acid rain web site, EPA estimates current conditions to be approximately 17,000 pounds per hour or 37 percent more than the NDDH inventory. However, no data is presented in the Draft EPA analyses showing the frequency distribution of emissions.

Table 3 presents the difference between current emissions and baseline emissions or net increment emissions. Generally, modeling is not preformed on this difference, but this table does illustrate the magnitude of the difference in estimates of increment consuming emissions. This table also includes increment expanding sources. Notably, EPA's Table 3-2 (p. 25) provides emission levels in lbs/hr. that do not add up. In fact, they are off by 602 lbs/hr.

The EPA inventory suggests that the baseline emissions were smaller than what NDDH estimated and the increases in increment consuming sources were larger. This results in greater increment consumption and is reflected in Table 3.

Table 2. Comparison of Current Emissions

Source	current (g/s)	NDDH Current Year (#/hr)	EPA Current Year (#/hr)	Difference (#/hr)
Antelope Valley Station 1	199.90	1,587	3,598	-2,011
Antelope Valley Station 2	187.30	1,487	3,598	-2,111
Coal Creek 1	430.20	3,414	5,077	-1,663
Coal Creek 2	376.50	2,988	4,195	-1,207
Coyote Station 1	487.70	3,871	5,077	-1,206
Grasslands Gas Plant	14.30	113	273	-160
Colstrip Station 3	93.60	743	2,945	-2,202
Colstrip Station 4	90.60	719	2,804	-2,085
Celp Boiler	52.90	420		420
Leland Olds Station 1	525.40	4,170	4,931	-761
Leland Olds Station 2	1,060.50	8,417	10,179	-1,762
Stanton Station	305.80	2,427	2,456	-29
Milton Young Station 1	644.60	5,116	5,575	-459
Milton Young Station 2	573.10	4,549	6,128	-1,579
Heskett Station 1	31.10	247	348	-101
Heskett Station 2	74.50	591	831	-240
Mandan Refinery	159.10	1,263		1,263
Lignite Gas Plant	13.20	105		105
Tioga Gas Plant	37.30	296		296
Beulah Station 1+2				
Beulah Station 3-5				
Neal Station 1 +2				
Flying J Ref Heaters+Boiler 2				
Flying J Boiler 1				
Flying J Boiler 3				
Royal Oak Boiler 1-3				
Royal Oak ACC				
Little Knife Gas Plant			427	-427
Dakota Gasification Synfuels Plant			3,323	-3,323
total		**42,523**	**61,765**	**-19,242**
Total (t/yr)	**(t/yr)**	**186,252**	**270,531**	**-84,279**

Note: Difference is NDDH-EPA

Table 3. *Comparison of NDDH and EPA Increment Emissions*

Source	NHHD Baseline (g/s)	NHHD Baseline (#/hr)	NDDH Current Year (#/hr)	NDDH Increment (#/hr)	EPA Baseline (#/hr)	EPA Current (#/hr)	EPA Increment (#/hr)	Difference (#/hr)
Antelope Valley Station 1			1,587	1,587		3,598	3,598	-2,011
Antelope Valley Station 2			1,487	1,487		3,598	3,598	-2,111
Coal Creek 1			3,414	3,414		5,077	5,077	-1,663
Coal Creek 2			2,988	2,988		4,195	4,195	-1,207
Coyote Station 1			3,871	3,871		5,077	5,077	-1,206
Grasslands Gas Plant			113	113		273	273	-160
Colstrip Station 3			743	743		2,945	2,945	-2,202
Colstrip Station 4			719	719		2,804	2,804	-2,085
Celp Boiler			420	420				420
Leland Olds Station 1	407.60	3,235	4,170	935	2,499	4,931	2,432	-1,497
Leland Olds Station 2	765.90	6,079	8,417	2,338	4,305	10,179	5,874	-3,536
Stanton Station	268.00	2,127	2,427	300		2,456	2,456	-2,156
Milton Young Station 1	585.90	4,650	5,116	466	3,972	5,575	1,603	-1,137
Milton Young Station 2	618.10	4,906	4,549	-357	5,635	6,128	493	-850
Heskett Station 1	65.20	517	247	-271		348	348	-619
Heskett Station 2	152.20	1,208	591	-617	1,749	831	-918	301
Mandan Refinery	312.90	2,483	1,263	-1,221				-1,221
Lignite Gas Plant	36.00	286	105	-181				-181
Tioga Gas Plant	135.30	1,074	296	-778				-778
Beulah Station 1+2	17.27	137		-137				-137
Beulah Station 3-5	28.29	225		-225				-225
Neal Station 1 +2	44.70	355		-355				-355
Flying J Ref Heaters+Boiler 2	3.19	25		-25				-25
Flying J Boiler 1	1.32	10		-10				-10
Flying J Boiler 3	1.89	15		-15				-15
Royal Oak Boiler 1-3	21.70	172		-172				-172
Royal Oak ACC	200.50	1,591		-1,591				-1,591
Little Knife Gas Plant						427	427	-427
Dakota Gasification Synfuels Plant						3,323	3,323	-3,323
Total		**29,097**	**42,523**	**13,427**	**18,160**	**61,765**	**43,605**	**-30,178**
Total (t/yr)		**127,444**	**186,252**	**58,808**	**79,541**	**270,531**	**190,990**	**-132,182**

Note: Difference is NDDH-EPA

Sources with PSD Increment Variances

There are two sources in North Dakota built after the major baseline was established which have been granted a Class I variance for the SO_2 increment. These are the Little Knife Gas Plant and the Dakota Gasification Synfuels Plant.

For the Little Knife Gas Plant, EPA assumed an emission rate of 427 pounds per hour or 1870 tons per year. EPA assumed that the emissions for the Dakota Gasification Synfuels Plant were 3,323 pounds per hour or 14,555 tons per year. The combined total is 16,425 tons per year. EPA simply states that these emission rates were obtained from a NDDH 1999 draft study (no other reference is provided). The Draft EPA Report does not present or justify that these emission rates are representative of actual emissions for the last two years.

These "variance" facilities, as part of their pre-construction PSD permitting, were excluded from Class I increment consumption when permitted and it is now inappropriate for the Draft EPA Report to include them in any cumulative increment analysis. In April 2002 NDDH developed revised reports regarding baseline emission inventory development[3] and CALPUFF modeling analysis[4]. These reports indicate that these sources should not be included in any Class 1 increment modeling analysis.

IV. Model Evaluation

Given the several technical uncertainties associated with the proposed CALPUFF model, it is important to perform a model evaluation to ensure accurate predictions. While EPA did such an evaluation, it was incomplete. Monitored impacts are a function of meteorological conditions that occur at the time measurements are made as well as corresponding emissions. It is the role of the draft CALPUFF model to use the actual meteorological conditions and corresponding emissions to replicate the measurements. Generally, model evaluations consider model

[3] NDDH, 2002, "Prevention of Significant Deterioration of Sulfur Dioxide Baseline Emission Rates" Draft
[4] NDDH, 2002, CALPUFF Analysis of Current PSD Class I Increment Consumption in North Dakota and Eastern Montana Using Actual Annual Average SO2 Emission Rates" Draft

predictions for an entire year, are compared to the same year of monitoring data and the maximum observed are compared to the maximum predicted. Because of uncertainties in wind direction, pairing measurements to model predictions at the same location and the same time is relaxed. In the EPA model evaluation, meteorological data from 1990 through 1994 were used and emission data from 1999 and 2000 were used. Based on the uncertainties in the emission inventory, this places similar uncertainties on EPA model evaluation. No discussion is provided in the Draft EPA Report regarding the SO_2 monitoring data that were used. While EPA identified two SO_2 monitors near the Theodore Roosevelt National Park, no information is provided on the exact location, the year or years of data used for comparison, the type of SO_2 monitors that were used, what QA/QC procedures were in place and the accuracy of the measurements. Thus, there is a great deal of uncertainty in this model evaluation and conclusions regarding model performance may be premature. In making model data comparisons, it is important to include error bands that reflect the uncertainty in the measurements. While this is typically not done, in this case (because such information should be readily available) it can address the question whether a change in model application will result in a statistically significant improvement in model performance.

V. CALPUFF Application and Interpretation of Results

The CALPUFF modeling presented in the Draft EPA Report relied upon the MESOPUFF II chemistry module. There is also an alternative chemistry module called RIVAD. IWAQM recommends the MESOPUFF II chemistry module but has not provided documentation to support this decision. The reaction rates are very different between these two chemistry modules and the MESOPUFF II chemistry is based on very different empirical rate constants. Given the importance of this in the current controversy, it would have been more appropriate to first test or evaluate the alternate chemistry module and determine how this could affect predicted concentrations and the model performance analysis.

Also, no information is provided regarding the wind fields during periods when CALPUFF is predicting that the SO_2 increment is being exceeded. This is important in assessing the adequacy of the modeling analysis as well as aiding in understanding the results.

The Draft EPA modeling analysis is complicated by the fact that there are increment consuming and expanding sources. It is not completely clear how EPA dealt with increment expanding sources in the context of CALPUFF in its Draft Report. It appears, that for each source EPA subtracted the increment expanding from increment consuming sources and used the resulting emission rate in the modeling. This concept will work in CALPUFF only if the increment consuming and expanding changes in emissions are for the same emission point or the sources are in close proximity and have similar stack parameters. However, a technical review of increment expanding sources indicates that the Draft EPA Report is flawed because it omitted the Mandan Refinery emission reductions from the modeling.

The EPA modeling results are summarized by highest and second highest predicted concentration and the number of times that the increment is exceeded for each averaging period for each year modeled. This data presentation does not provide any information whether these modeled concentrations pertain to all receptors or only the highest receptor.

VI. Conclusions

Based on my technical review, there are several key technical issues pertaining to the EPA increment consumption analysis that make it unsuitable for additional regulatory policy analysis.